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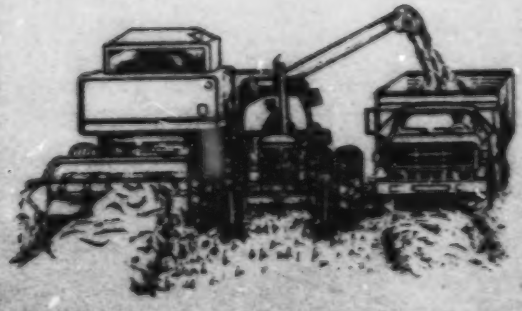

POTENTIAL OF CHAFF

Foreword

The purpose of this bulletin is to increase the awareness of chaff as a feed source for livestock. Since feed supplies are in limited supply and cereal grain acreages are always high, the potential for chaff is unlimited. Due to the high cost of land and narrow profit margins for livestock and feed producers, it may be impractical to produce hay on farmland. Although chaff has often been called an alternative feed, its consistent availability and low cost are making it a major feed for many mixed farms every year.

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Quality and Quantity

Chaff includes the glumes, hulls, unthreshed heads, short straw, leaf material, weed seeds and whole or cracked grain kernels. It is not a consistent product since it varies with the weather, moisture content and speed, quality and adjustments of combining. If conditions are dry and/or the crop is short, more straw will be collected in the chaff.

The quality of chaff varies a great deal. As combine efficiency is decreased, more cracked kernels and unthreshed heads are passed over the sieve and collected in the chaff as feed.

Estimates of average combine losses are:

1. Sieve loss 1% loss of free and cracked grain
   .5% loss of unthreshed grain

2. Walker loss 1% loss of free grain
   .5% loss of unthreshed grain

From a 1000 seeded acre farm, the 1.5% of lost grain in chaff could have a feed value of $1,350 per year.

1.5% x 30 bu/ac x 1,000 acres x $3.00/bu = $1,350.

Average chaff will have an expected feed value of 3.5% crude protein (CP) and 35% total digestible nutrients (TDN or energy). This will vary with the contents of the chaff, nutrient level of crop and extent of weathering. The nutritive value of chaff varies from somewhat better than straw to the equivalent of a low quality hay. Animal intake of chaff is higher than straw since the chaff is less bulky and has a smaller particle size.

Contrary to general impressions, the quantity of chaff produced is relatively consistent. Even though grain yield may vary considerably, the chaff production remains more constant. Under crop stress, the chaff or glumes are developed early, but the grain within the head may never fill.

This results in consistent chaff production and more small or cracked kernels in the chaff. More chaff is produced when combining dry straw than when it is tough.

The average chaff collected from a 30 bushel crop would be one ton for every 5 acres. This equals 200 tons of feed for a 1000 seeded acre farm. Since beef cows eat approximately 20 lbs. of chaff per day, a mixed farm could winter 110 cows.

110 cows x 20 lbs./day x 180 days = 198 tons

Chaff holds the potential to reduce feed shortages. With the amount of cereal grain production in Saskatchewan, feed shortages could be a thing of the past.

Advantages of Chaff

- dependable feed source
- large quantities available
- good land can be used for grain or cash crops instead of forage
- economical feed supply
- easily fed
- requires no grinding
- contains valuable nutrients in the grain and weed seeds
- easily collected and handled
- requires low manpower
- higher animal intake than straw
- ideal for ammoniation
- can be left in the field for direct cattle consumption
- removes weed and volunteer grain seeds from field
- eliminates chaff rows behind combine for future crop uniformity
- leaves straw on land for soil conservation

Disadvantages of Chaff

- minor hassles during harvest
- requires supplementary protein, minerals, vitamin A and possibly energy
- feed storage left until fall
- wastage due to wind and moisture when piles left in field until late fall

Supplements

When feeding chaff and straw based diets it is imperative the animals receive supplemental vitamin A (either injection or in diet), minerals (including cobalt-iodized trace mineralized salt, calcium and phosphorus) and additional protein (rapeseed meal, alfalfa hay, dehydrated pellets, commercial supplement or ammoniated feed). Grain should also be supplemented in the diet when temperatures go below −20°C or if cows are in poor conditions. Animals must have free access to good quality water at all times and adequate energy to reduce the possibility of rumen impaction.

Ammoniation of Chaff

Ammoniation is a method of treating low quality hay and crop residues, such as chaff and straw, to improve their nutritional value as feed for ruminant animals. This can be accomplished using anhydrous ammonia fertilizer. The higher the feed value of the original crop residue, the higher will be the quality of the ammoniated feed. Chaff will vary from 3.3 to 4.3% in CP and from 33 to 43% in TDN. Following ammoniation, the chaff could contain from 8 to 12% CP and from 43 to 54% TDN.

Generally, the ammoniated chaff could have CP and TDN contents similar to a medium quality hay.

No problems such as abortions, light weight calves or any reproductive difficulties have been reported which could be associated with rations containing ammoniated feeds. No incidents of impaction by animals on ammoniated feed have been reported although they could occur if the ration contained inadequate energy. Ammoniation of chaff reduces grain requirements but does not eliminate them in all situations.

The Ammoniation Process

The ammoniation process has several distinct steps, some of which require additional manpower. The increase in feed value is determined by a number of factors.

Moisture: The moisture content of the chaff must be at least 15 to 20% to achieve a good response to the ammonia treatment. When dry grain is combined, chaff will be in the range of 8 to 12% moisture and water must be added prior to ammoniation. This can be accomplished by spraying water onto each load of chaff as it is brought in from the field and mixing it up as well as possible while forming it into the proper shaped pile for treatment with ammonia. Another method is to form the chaff pile and add water through a hose or pipe inserted into the surface of the chaff pile. In order to get a reasonably even distribution of water throughout the stack, the proper amount of water must be added to each square foot within the pile.

Temperature: The rate and extent of the reaction of ammonia with chaff is affected by temperature. A better reaction is achieved if the temperature of the chaff is fairly high when it comes into contact with the ammonia. If the chaff is cold, it may be advantegeous to allow some heating to take place before the ammonia is added. In this situation it will be necessary to place the ammonia pipes about 6 feet apart to stop the heating completely.

Covering Chaff With Plastic: A better response is obtained if the chaff is sealed in plastic before the ammonia is added. A 100 ft. by 40 ft. sheet of 6 mil, black polyethylene is the largest available and will cover about 40 tons of chaff. The plastic must be sealed around the base of the stack and should be covered with ropes or a fishnet to protect it against wind damage.

Ammonia Application: Anhydrous ammonia is a very dangerous substance. The ammonia dealers are properly trained and have proper protective clothing to handle ammonia with a minimum chance of having an accident. They can meter out 3 to 3.5% ammonia accurately, based on the dry matter content of the chaff, through perforated iron pipes inserted about 8 feet apart along the length of the pile. These pipes should be 1.5 inches in diameter, 20 to 22 feet long and contain a number of 3/16 inch diameter holes placed 16 inches apart along the length of the pipe.

They should be pointed at one end and on the other end contain an adaptor to fit the valve on the ammonia hose and a means to push them into the chaff pile.

The plastic should be left on the stack for a minimum of 21 days to allow the chemical reaction to go to completion. It can then be removed or left in place until the chaff is to be fed.

Uncovered piles of chaff have been ammoniated with reasonable success over the past two or three years. Although the quality of the chaff ammoniated in this manner is considerably less than chaff ammoniated under plastic cover it may still be adequate. Some producers believe that the acceptance by the cattle and the condition of the cattle at calving time was just as good as with chaff ammoniated under a cover. As yet no trials have been conducted to confirm this observation. The following are recommendations which will improve the quality of an uncovered stack.

1. Moisture levels should be higher than for a covered stack (20-25% moisture);

2. Pipe placement for anhydrous application should be spaced 6-8 feet apart. Distribution of the anhydrous throughout the stack is crucial or some spoilage will occur;

3. The minimum stack height should possibly be 10 feet to reduce the anhydrous vapour loss.

These guidelines for ammoniation are very simplified. Before proceeding it would be advisable to consult your Agricultural Representative or Livestock Specialist.

The following publication giving detailed procedures is available from your nearest office of Saskatchewan Agriculture or the Division of Extension and Community Relations of the University of Saskatchewan at Saskatoon.

Ammoniation of Straw and Chaff. University of Saskatchewan Publication No. 453 by Jack Kernan and Jerry Knipfel.

COST OF AMMONIATION

Covered Chaff (40 tonne at 12% moisture)

Supplies		
Ammonia at $370/tonne, 40 T x 88% DM x 3.5% x $370/T NH_3	= $456	
Plastic at $110/sheet	= 110	
Fishnet at $80/net/4 stacks	= 20	
Total		$586
Labour (Person hours at $9/hour)		
Adding water	2 hrs (1 person)	
Shaping pile	1 hr (1 person)	
Covering (plastic and net)	6 hrs (3 persons)	
Inserting and removing pipes during ammoniation	2 hrs (3 persons)	
Total	11 hrs	$ 99
Tractor use (1 hour)		$ 16
4 pipes (capital exp., 80 tonne/yr, 10 yr at $162/pipe)		$ 20
Total Cost		$721
Cost/tonne		18
Cost/ton		16

Uncovered Chaff (40 tonne at 12% Moisture)

Supplies		
Ammonia at $370/tonne		$456
Labour (Person hours at $9 hour)		
Adding Water	2 hrs (1 person)	
Shaping Pile	1 hr (1 person)	
Inserting and removing pipes during ammoniation	2 hrs (3 persons)	
Total	5 hrs	$ 45
Tractor use (1 hour)		$ 16
4 pipes (capital expense)		$ 20
Total Cost		$537
Cost/tonne		13
Cost/ton		12

Advantages of ammoniated chaff over untreated chaff

- increase CP (crude protein) two to three times initial CP
- increase TDN (energy) from 8% to 14%
- increased palatability
- increased consumption
- constitute major component of cow ration
- weed seeds left non-viable

Disadvantages

- added cost
- added labour requirement

Chaff Collecting and Handling

This section outlines the comparisons and costs of various handling systems. For detailed information:

1. Chaff Collecting and Handling: Ted Padbury, Agriculture Engineer, Saskatchewan Agriculture

2. Chaff Collecting, Hauling and Packing Costs 1984: Farm Business Management Data Manual 500:12, Saskatchewan Agriculture

Systems

The collection of chaff is achieved by a side auger directly behind the combine shoe. A blower with an adjustable spout directs the chaff into a trailing wagon. The chaff can be packaged in various manners:

1. Small chaff wagon

This wagon can be emptied on the go with an electric, hydraulic or rope trip. It leaves an average pile of 800 lbs which is left in the field for later retrieval into the feeding area. The piles can also be left in the field for fall grazing.

2. Large chaff wagon

These wagons may hold 4600 lbs and when full are disconnected from the combine and replaced with a second empty wagon. Stop time is approximately one minute. The full wagon is hauled by truck directly to the feeding area and emptied with the use of a baffle board and cables. This system illiminates wastage in the field. It does require an additional man during the harvesting operation, however, the chaff collection and hauling is completed when harvesting is finished.

3. High dump silage wagon

Approximately 1000 pounds of chaff can be collected in a silage wagon and dumped directly into a truck for hauling. This also requires an additional man but eliminates field wastage. This method has similar advantages as 2 but travelling and unloading times are reduced.

4. Chaff and straw baled

Chaff, by use of a cyclone, can be deposited on top of the straw swath. This allows collection of the chaff within the straw bales. This method is not recommended in the southern portion of the grain belt since it involves the removal of the straw from the land.

The small chaff piles which are dumped in the fields can be collected and transported by various methods:

1. Loose stack wagons

   The McKee, Hesston or John Deere stack movers can pick up and haul these piles

2. Push-off stacker

   Front end loaders can be modified to pickup and dump chaff piles into trucks for transport.

3. Redekop Chaff-O-Matic

   This system is designed with a pickup and suction blower to deposit chaff in a modified truck box

4. McKee and Rem pickups and blowers

   These can be modified to blow chaff into a truck or wagon

5. Specially designed sweep and medium height truck box. This method is particularly attractive for small operators where hauling distances are short.

Chaff and Hay Cost Comparison

The average cost per ton for packaging, collecting and hauling:

Chaff

100 ton volume	Cost Per Ton (1)
Large chaff wagon	19.00
High dump wagon	24.00
Stack movers	29.00
Vacuum blowers	34.00
Push-off stacker	40.00
Redekop Chaff-O-Matic	46.00
Average	$32.00/ton

Hay

100 ton volume	Cost Per Tonne (2)	Cost Per Ton
Windrower	9.60	
Large round baler	27.29	
3-ton truck, FEL	11.70	
Total	48.59	44.07

(1) Chaff Collecting, Hauling and Packing Costs 1984: Farm Management Section, Data Manual 500.12

(2) Forage Harvesting and Hauling Comparisons 1981: Farm Management Section, Data Manual 500.15

Note: Costs may be lower for handling larger volumes, having multi-owners or using systems with lower original cash costs. Hay system will require additional land, opportunity and production costs while chaff is a by-product of the grain enterprise. Higher net incomes may be realized by

having cattle fed ammoniated chaff compared to taking land out of grain production to grow hay for a similiar number of cattle.

Feeding Systems

There are three options for feeding chaff:

1. Electric wire:

This system involves the cattle moving to the feed. A two telephone wire system (one electrified, one ground) is recommended, however, a single electrified wire or posi-shock wire are also being used. A good, CSA approved, solid state shocker is required. The wire is insulated and suspended in front of the feed. The cattle must feed over and under the wire which is adjusted daily. Proper adjustments will ensure little or no wastage. Feeding time can be as low as ten minutes per day per herd.

2. Movable Feed Racks

These racks are constructed of wood or pipe sections. They vary from 10 to 20 feet and are positioned in front of the chaff. The cattle feed through the fence which is moved toward the stack as necessary. This system can also limit labour to ten minutes per day per herd.

3. Fixed Feed Racks

This method involves moving the feed to the cattle. With the use of a tractor, front end loader, bucket and/or grapple fork the chaff is transported to wood or metal feeders. The labour requirement varies greatly due to farm situations.

All these feeding systems can allow the cattle free choice or limited access. Since large round bales and loose hay can be substituted into these feeding systems, a cost comparison shows no advantage or disadvantage for chaff as a roughage.

Cows require approximately 24 lbs. per day of medium quality roughage. If allowed free access, they will over-eat up to 30-40 pounds per day with no additional gain. Also, if any roughage is fed in a free choice feeder, wastage could significantly increase the feed required. Over consumption and wasted feed could double the cost of feed per day.

For more specific information on feeding systems contact your Agricultural Representative or Regional Farmstead Engineer for the following publications:

1. Beef Cattle Feeding Systems Comparisons: Ted Padbury, Saskatchewan Agriculture, Livestock Facilities Engineer.
2. Farm Feed Processing and Handling: Agriculture Canada publication 1572E.
3. Beef Cattle Feeding Comparisons: Saskatchewan Agriculture, Farm Management Section.

Table I

Cost Comparison of Various Roughage Sources ($ per ton)

	Chaff	Ammoniated Chaff	Hay	Purchased Hay
Cost of production (1)	-	-	68.00	-
Collecting and Handling (2)	32.00	32.00	44.00	-
Ammoniation (3)	-	17.00	-	-
Cost of feeding (4)	2.31	2.31	2.31	2.31
Purchase price (5)	-	-	-	68.00
Additional trucking (6)	-	-	-	10.00
Total ($/ton)	34.31	50.31	114.31	80.31

Assumption

(1) Cost of production

Chaff: by-product of cereal grain production
Hay: source: Dryland Forage Production Costs 1987 Farm Management Section, Data Manual
- includes cash operating (fuel, repairs) and fixed (land, machinery, investment, depreciation, etc.)
- brown soil zone
- four out of six years production
- $54.28/rotation acre production cost (1200 acres)
- average production .8 tons per rotation acre
- $54.28 per rotation acre divided by .8 ton per acre equals $67.85/ton

(2) Collecting and handling

Chaff: page 7
Hay: page 7

(3) Ammoniation

Chaff: page 5

(4) Cost of feeding

source: Beef Cattle Feeding Systems Comparison, Saskatchewan Agriculture
- electric wire

(5) Purchase price

source: Saskatchewan Agriculture Forage Listing Service
- weighted average listing price brome-alfalfa hay 1985-1986

(6) Additional trucking

- $2.50 per loaded mile
- average estimate haul of 100 miles
- 25 ton per load

Note: Individual costs will vary depending on the particular farm situation.

Table II

Cost Comparison of Equivalent Balanced Rations (mid-pregnancy)

	Cost (lbs) / Cow/day		
	Chaff	Ammoniated Chaff	Purchased Hay
Roughage (1)	31¢ (18 lbs)	63¢ (25 lbs)	88¢ (22 lbs)
Energy (barley) (2)	18¢ (6 lbs)	00¢ (0 lbs)	00¢ (0 lbs)
Protein (32% supp.) (3)	12¢ (1 lb)	00¢ (0 lbs)	00¢ (0 lbs)
Mineral (1:1) (4)	08¢ (4 oz)	08¢ (4 oz)	04¢ (2 oz)
Vitamin (A,D,E) (5)	00¢ (40,000 IU)	00¢ (40,000 IU)	00¢ (40,000 IU)
TOTAL (cost/cow/day)	69¢	71¢	92¢

Assumptions:

All rations are balanced for energy, protein, mineral and vitamin: Appendix I

(1) Roughage
- cost page 10
- chaff: $34.31/ton = $.017/lb.
- ammoniated chaff: $51.31/ton = $.026/lb.
- purchased hay: $80.31/ton = $.04/lb.

(2) Energy (barley)
- source: Saskatchewan Agriculture Market Trends February 25, 1987, 1 c.w. barley $65.00/tonne = $1.41/bu. per tonne = .03¢/lb.

- extra barley must be added to all rations if cows are in poor condition or the temperature falls below −20 C

(3) Protein (32% supplement)
- survey $6.50 per bag
  $6.50/bag divided by 55 lbs/bag equals $.12c/ per lb.

(4) Mineral (1:1)
- survey $15.00 per bag
- $15.00 per bag divided by 55 lbs. per bag divided by 16 oz. per lb. equals $.02/oz.

(5) Vitamin (A,D,E)
- recommended for all rations
- costs less than $.01/day

Note: Specific rations must be formulated on individual feed test results.
: Contact your Agricultural Representative or Livestock Specialist for assistance to formulate least cost rations.
: Barley price of $77.28/tonne = $1.68/bu. = $.035/lb. would make the Chaff and Ammoniated Chaff Rations equal cost/day.
: Rations for Uncovered Ammoniated Chaff piles could be cheaper if quality is high.
: Wastage or excessive eating will significantly increase the feed cost/day.
: Appendix I shows the guidelines used in determining the feed requirements used in Table II.

Summary

Chaff could become a major feed source in Saskatchewan because of its numerous advantages. It is a dependable and economical feed supply and requires no extra land for hay production. It has a number of agronomic advantages and its removal from the land does not affect soil conservation practices.

Ammoniation is a low cost alternative to significantly increase the feed value of chaff to the equivalent of a medium quality hay.

Chaff can be economically collected and handled and could be substituted into many existing feeding systems.

Chaff and ammoniated chaff have been formulated into balanced rations and has considerably reduced the feeding cost per head per day. Utilization of chaff could hold the potential for increased profits in a livestock enterprise.

Appendix I: Determining Feed Requirements for Table II

Requirements: (mid-pregnancy)
TDN (energy) 10-12 lbs./day
Protein 1.5-1.8 lbs./day

Assumptions:	TDN	Protein
Chaff	35%	3.5%
Ammoniated Chaff	45%	9%
Hay	52%	10%
Barley	74%	11%
32% Supplement	50%	32%

Table III: Equivalent Balanced Rations (mid-pregnancy)

Chaff Ration:	TDN (lbs/day)	Protein (lbs/day)
Chaff	18 lbs x .35 = 6.30	18 lbs x .035 = .63
Barley	6 lbs x .74 = 4.44	6 lbs x .11 = .66
Supplement	1 lb x .50 = .50	1 lb x .32 = .32
	11.24	= 1.61

Ammoniated Chaff Ration:

Ammoniated Chaff	25 lbs x .45 = 11.25	25 lbs x .09 = 2.25

Hay Ration:

Hay	22 lbs x .52 = 11.44	22 lbs x .10 = 2.2